POULTRY WATER QUALITY HANDBOOK

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The number of people employed in the industry is difficult to compute, especially if one includes very small operations, and the many off-farm laborers who work in hatcheries, live-bird processing plants, feed mills, and other allied operations serving the industry. Nevertheless, about 70,100 farms reported poultry inventories to the 1992 Census of Agriculture (so that type of farm = poultry); and during the same Census, some 35,000 operations reported poultry-related sales of $1,000 or more under the Standard Industrial Classification (SIC) 025 for poultry and eggs. That is,

- 18,284 farms are categorized as "broilers, fryers and roaster chickens" (SIC 0251);
- 10,636, as "chicken eggs" (SIC 0252);
- 3,361, as "turkey and turkey eggs" (SIC 0253);
- 427, as "poultry hatcheries" (SIC 0254); and
- 2,358, as "poultry and eggs, n.e.c." (SIC 0259).

These numbers establish only the minimum threshold for the size of the industry; however, the estimated and combined value of these markets to each state (based on cash receipts collected in 1996) are shown in Figure 1. The income figures are impressive — as they have been for almost 30 years — and they are expected to increase — probably as much as 5 percent each year into the future.

Responsible Waste Management — the Environmental Challenge

Such impressive growth is accompanied by an additional yearly legacy. Every increase in poultry production increases the production of manure, used litter, carcasses, and the flow of wastewater from hatchery, egg, layer, and live-bird processing operations. These by-products must be safely disposed of, or used, to ensure that they do not lead to air or water pollution. The challenge for the industry is where and how to use these poultry wastes to benefit the grower and protect the environment.

The rapid growth of the poultry industry internationally only augments the challenge, as does the clustering of poultry operations near food processing plants or large urban markets. The problem is simple to explain, but not so easily solved.

The traditional use for poultry by-products is land application, but land resources are not always sufficient. Expanded or new uses for poultry waste must be sought: for example, poultry waste can and has been used as an ingredient in organic fertilizers, as a horticultural and mushroom growing medium, and as an ingredient in feed products for livestock, dogs, cats, and aquaculture. Indeed, a continuing search for additional uses is part of the challenge of modern production methods.

The poultry industry is committed to protecting water and air quality, the environment and natural resources. Growers in particular share responsibility with other segments of the agricultural community and all citizens for nonpoint source pollution: the pollution that originates from diffuse sources (e.g., agricultural runoff, urban stormwater runoff, and erosion). Some segments of the poultry industry may also contribute to point source pollution: the pollution that issues from a known or direct discharge (e.g., wastewater discharged from the end of a pipe or discharges from processing or treatment plants).

Understanding the complexity of poultry operations can help us address these potential water quality and environmental issues. The industry is separated into hatchery, breeder, broiler-roaster-Cornish game hens (meat types), and turkey, egg, duck, and other poultry and live-bird processing operations. Each of these operations produces dry or liquid waste and dead birds. Recent developments have shifted environmental awareness beyond live-bird processing plants (offal, feathers, and wastewater) to focus on growers. The shift reflects an increasing awareness of how agricultural runoff affects water quality. It also recognizes that the growth of the industry (and its concentration in certain regions) elevates animal waste management to the status of a major problem.

An Outcome of Modern Production Methods

As any poultry grower knows, the speed, efficiency, and methods used to produce poultry and poultry products have changed drastically during the last 25 years as growers applied

These on-farm pollutants may originate in manure, litter, or dead birds. How such wastes are disposed of, treated, or managed will directly influence the cleanliness and safety of surface and groundwater resources. Air quality may also be affected by improperly handled poultry by-products. Air and soil are less obvious but no less important media for transporting these pollutants into the environment.

Disposing of spent hens (breeders or table egg layers after their production cycle) and dead birds is an increasing problem. The daily numbers and volume of dead birds will be predicated on the birds' age and weight, the number of birds in the poultry house, and climatic conditions. Acceptable methods of disposal include (1) burial, (2) incineration, (3) composting, and (4) rendering. Burial pits may have severe environmental limitations in areas of porous or fractured soils that would allow leaching of nutrients to groundwater. Incineration has some limitations, including the possibility of air pollution and increased fuel and labor costs.

Many progressive growers are switching to composting or to rendering as preferred solutions from an environmental and economic viewpoint. A grower must choose a method compatible with his or her individual operation and company preference. Dead birds must be treated as a resource that can add value to a grower's operation. Improper methods of disposal are unacceptable and cannot be condoned.

The magnitude of the problem underscores the advantage to be gained from its alternative: namely, that properly managed poultry wastes from manure, litter, dead birds, and wastewater are profitable farm investments. An effective waste management plan provides for the proper collection, storage, handling, and use of poultry waste. Products derived from wastes will reduce chemical fertilizer costs, improve soil quality, and protect water resources, air quality, and human and animal health. Effective waste management will also promote a favorable public attitude toward the industry.

There is not a single best or optimal approach to protect or preserve water quality and the environment. Good waste management practices are essential if the poultry industry is to continue to grow and thrive under today's environmental and societal challenges. The remainder of this handbook relates to poultry waste management (PWM) and poultry mortality management (PMM), and wastewater concerns. Information sheets on these topics provide management "guidance" to help poultry producers make sound environmental decisions; additional fact sheets discuss other environmental issues (OEI) and alternative technologies (AT). Sources of assistance are profiled in the section on Resource Information (RI).

In general, environmental needs and solutions are site specific and regional in nature. Local sources of information, including industry associations, appropriate state agencies, soil and water conservation districts, and the USDA Natural Resources Conservation Service and Cooperative Research Extension, and Education Service offices, should be consulted to ensure that your waste management plan complies with all state and federal regulations.

Producers using this handbook are encouraged to seek assistance from local, state and federal agencies, private consultants, and other professionals on how to implement waste management techniques that protect water quality and the environment. Water quality regulations and permitting requirements vary from state to state and may be more stringent than national regulations.

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Poultry Production and Water Quality

Every year, environmental issues seem to gain emphasis nationally and internationally as the importance of a cleaner environment and respect for pollution prevention practices receive increasing public support. The matter is most pressing to livestock and poultry producers because as environmental sophistication grows so does the focus on nonpoint source pollution. What is more, this deeper environmental sensitivity has occurred simultaneously with an extraordinary increase in the size of the poultry industry and its concentration in certain regions near processing and packing plants. The potential for adverse environmental impact appears greater as a result of the industry's trend to grow ever larger numbers of birds on smaller areas of land.

Understanding Animal Wastes and the Environment

Good waste management practices are essential for preventing the transport of sediments, nutrients, and bacteria into groundwater, rivers, and streams — that is, to prevent pollution — and to protect agricultural resources. The latter aspect of waste management ensures that growers will get the best return on their investments since animal waste is also a valuable resource, a collection of by-products that can be reclaimed for other uses.

The term "poultry waste" generally refers to manure: the feces and uric acid excreted by the growing birds; "litter," on the other hand, refers to manure and used bedding materials. Other wastes associated with poultry production include washwater, storm (and muddy) water runoff, and the carcasses of dead birds and spent hens. Processing wastes include other rendering and lagoon residuals.

These same materials, however, contain (1) valuable nutrients that can reduce the need for commercial fertilizers and increase plant yield; and (2) organic matter that can improve soil quality and extend its ability to hold water. Little wonder, then, that what happens to these by-products can be good or bad for the industry and for the environment.

On the one hand, poultry wastes can do a lot of good. They can be used as fertilizer, soil enhancers, cattle feed, or energy. Poultry producers can add value to these products — and prevent them from contaminating surface and groundwater — by using proven, acceptable methods of collection, storage and handling, treatment, disposal, and management. All such beneficial uses depend on proper management. Without such management, the value of the waste will decline rapidly, even as its potential for adversely affecting the environment and water quality steadily rises.

Pollution Is Not Inevitable

Poultry growers, whether their operation is consolidated or diversified need not produce any pollution outside the system. Pollution occurs only when litter is mismanaged — for example, when it is land applied in quantities that exceed plant needs, or when the ground is wet or frozen. As a result of such applications, potentially contaminating substances become "available" to the environment. If they also become "detached" from the site, for example, by being adsorbed to sediments or dissolved in water, they can be "transported" off site. Transport occurs when contaminants in the animal waste (the unused nutrients, bacteria or other elements in the litter) are released to surface drainage or infiltrate beneath the soil surface in groundwater recharge areas.

stormwater runoff, a nonpoint source of water pollution. Similarly, some livestock facilities may be regulated as point sources when they are collecting, storing or conveying facility wastewater and runoff; but once the manure or litter has been applied to the land, it is managed as a nonpoint source. Poultry growers must know how to manage point and nonpoint sources.

General Guidelines

Since the Clean Water Act was passed in 1972, concentrated animal feeding operations (CAFOs), including some large poultry houses, have been regulated as point sources of pollution. Federal law which the states administer through the National Pollutant Discharge Elimination System (NPDES) program forbids point source discharges, that is, the discharge of any pollutant or contaminant to "waters of the United States."

Thus, CAFOs, like other point sources, must obtain an operating permit which prohibits discharge except from lagoons during storm events greater than 24-hour, 25-year storms. The permit also specifies best management practices to protect surface water, including diverting off-site drainage around the facilities and designing appropriate storage facilities for manure and process-generated wastewater. Adequate runoff storage must be included in the design; lagoons or holding ponds must be sized to withstand a 25-year, 24-hour duration storm.

Nonpoint Source Prevention Practices

The extent of nonpoint sources has been more fully realized in the last decade, but they are usually assessed locally on a stream-by-stream basis and controlled by conservation or "best management practices" (BMPs). BMPs are routine activities that can be incorporated in animal and crop farming to conserve natural resources and protect air, soil, and water quality. They are structures or activities that reduce the potentially harmful effects of agricultural production.

State and local Guidelines

Most states now require (1) permits for the operation and construction of confined animal facilities whether current or planned, if the facility uses a liquid waste management system; and (2) that all livestock farmers plan their waste management and disposal system, especially as it concerns land applications. Whether these plans are written, kept on file, or simply in evidence on site, may depend on other circumstances.

The conditions pertaining to permits are not uniform across the states, but they usually provide specific guidance for operations at, under, or exceeding a certain size; establish setback distances for grower houses, lagoons, and waste management structures (to protect water and air quality and to limit any nuisances that might impinge on nearby homes or public buildings, such as schools and churches); buffer zones; and design specifications for new construction.

Land application requirements generally establish when and where applications can be permitted; for example, only at approved rates, and with nutrient management planning; not on frozen ground or when rain is expected on slopes greater than 15 percent, or on setbacks from public buildings and property lines. Typical setback distances for land applications are 100 feet from streams or ponds, sinkholes, wells, and water supplies, and 50 feet from any water lines or known agricultural drains.

Getting Help

A system of standard operating procedures or practices developed in accord with, or as part of, a "resource management plan, or "animal waste management system" recommended by the USDA Natural Resources Conservation Service (NRCS), will generally meet state and local requirements. The NRCS offers technical assistance to growers and often works with local soil and water conservation districts and state and local agencies to help farmers write suitable plans.

Such guidance augments the grower's own engineering and technical resources and makes it easier to adapt national conservation practices to regional conditions. It may also be possible that growers are eligible for cost-sharing. The USDA has used cost-share programs to encourage conservation over many years. Similar programs may now exist or are being developed.

tion, although agriculture and forestry management are not the only sources. Crop production, pastures, rangeland, feedlots and other animal holding areas are agricultural sources of the U.S. waters assessed, 50 to 60 percent of the water quality problems in rivers and lakes and 34 percent of the waters in more urbanized coastal areas are impaired from agricultural sources. Bacteria, sedimentation, and nutrients are the leading pollutants.

Properly managing manure, controlling runoff, and nutrient management planning in conjunction with land applications will reduce or eliminate much of the proposed source of pollution and contribute to more productive farming. Most nonpoint source pollution problems can be controlled if growers know how nutrients and soil interact and plan accordingly.

Nitrogen, phosphorus, and potassium move through cycles on a farm. As nutrients, they go from crops to animals (in feed) to the soil (waste applications) and back again to other crops. If the cycle holds, everything works as it should. But too many nutrients already in the soil or too much waste applied to the land can move with the soil into surface water or through the soil into groundwater until their presence in the water reaches unacceptable levels, that is, is sufficient to impair water quality.

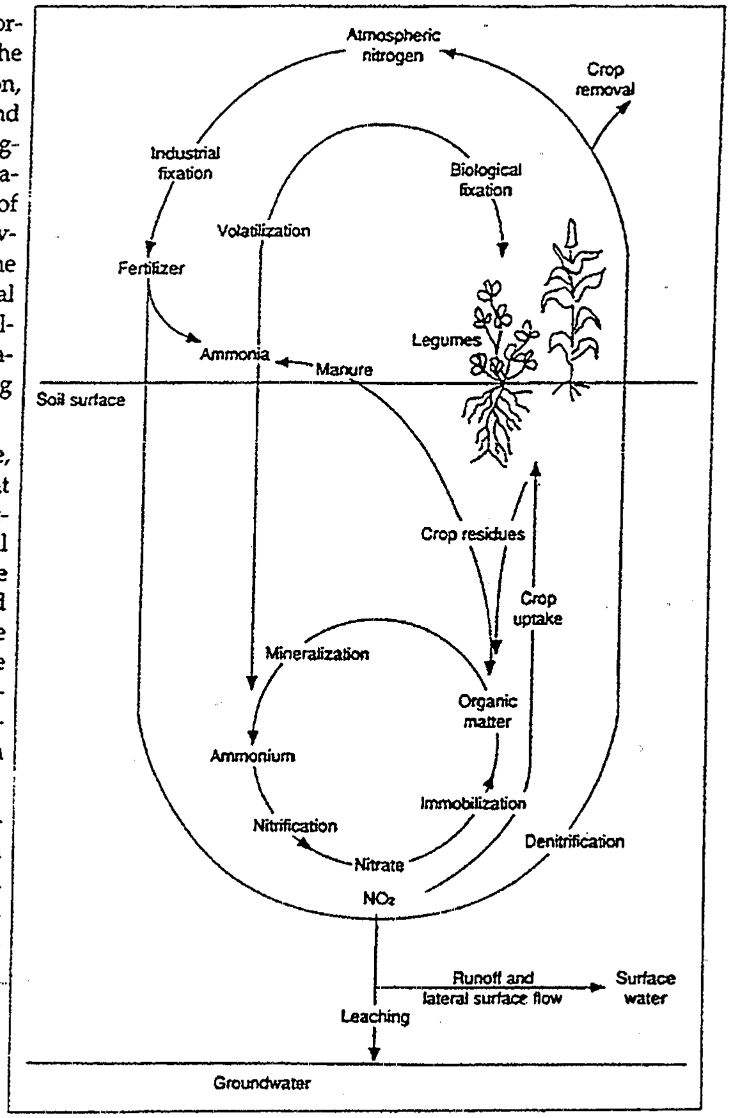

Figure 1.—The nitrogen cycle. Source: Pennsylvania State University, College of Agriculture. 1989. Groundwater and Agriculture in Pennsylvania. Circular 341. Reprinted with permission.

Nitrogen

Of the three major nutrients in poultry waste, nitrogen is the most complex and hence the most likely to contribute to environmental problems. Most of earth's nitrogen exists as nitrogen gas in the atmosphere (see Fig. 1). It can be transformed into inorganic forms by lightning or into organic forms by plants, such as soybeans, alfalfa, or clovers. Nitrogen can also be transformed into inorganic forms (commercial fertilizers) by energy intensive processes.

Most of the nitrogen found in animal wastes is organic nitrogen. A smaller amount of the nitrogen in litter is ammonium. Organic nitrogen can be mineralized or converted by soil bacteria into inorganic nitrogen, the form in which nitrogen is available to plants. Excessive organic and ammonium forms of nitrogen will be transformed in soil into nitrate nitrogen (that is, into water soluble nitrogen).

- organic phosphorus, which is found in dead and living materials;
- precipitate phosphorus, which is mainly fertilizer that has reacted with calcium, aluminum, and iron in the soil; and
- mineral phosphorus, the phosphorus in various soil minerals.

Approximately two-thirds of the total phosphorus in soil is inorganic phosphorus; the remaining one-third is organic. Both forms are involved in transformations that release water-soluble phosphorus (which can be used by plants) from solid forms, and vice versa.

Phosphorus-laden soil or dissolved phosphorus can move via runoff into rivers, lakes, and streams, where it causes excessive plant and algae growth, which in turn depletes the dissolved oxygen content in the water. Phosphorus-enriched waters contribute to fish kills and the premature aging of the waterbody. In the end, the beauty and use of the waters are seriously curtailed. Even relatively small soil losses may result in significant nutrient depositions in the water.

Controlling soil erosion and proper land application of phosphorus-containing wastes will greatly reduce the amount of phosphorus in water. While not normally a great concern, care must also be taken to prevent soluble phosphorus from leaching into groundwater.

Applying poultry waste to land at rates based on supplying the nitrogen needs of grain or cereal crops can lead to a phosphorus buildup in the soil. Planting forage crops in rotation with grain crops will help remove excess phosphorus. Maintaining soil pH at the recommended level is also an effective and economical practice for maximizing phosphorus efficiency. Crops use phosphorus most efficiently when the soil pH is between 6.0 and 7.0.

Soil phosphate levels are an important consideration in calculating poultry litter application rates. Land applications should be made only to soils that do not already contain excessive phosphate levels. An analysis or test should be conducted on each waste source prior to land application to determine proper phosphorus application rates.

Potassium

Potassium in poultry waste is a soluble nutrient equivalent to fertilizer potassium. It is immediately available to plants when it is applied. Potassium is fairly mobile but does remain in the soil to help supply plant needs, for example, strong stems, resistance to disease, and the formation and transfer of starches, sugars, and oils. Excessive amounts of potassium can inhibit or restrict the growth of some plants at certain stages of development. Small amounts of potassium may be leached to groundwater, especially in sandy soils; however, potassium or potash is usually not a threat to water quality or considered a pollutant.

Heavy Metals and Trace Elements

Heavy metals and trace elements, such as copper, selenium, nickel, lead, and zinc, are strongly adsorbed to clay soils or complexed (chelated) with soil organic matter, which reduces their potential for contaminating groundwater. However, excessive applications of organic waste containing high amounts of heavy metals or trace elements can exceed the adsorptive capacity of the soil and increase the potential for groundwater contamination. Excessive application of some heavy metals, for example, copper can be toxic to plants whose growth is needed to take up other nutrients.

Surface water contamination is a potential hazard if poultry wastes are applied to areas subject to a high rate of runoff or erosion.

Salts

Dissolved salts, mainly sodium, in high concentrations interfere with plant growth and seed germination, and may limit the choice of plant species that can be successfully grown. Poultry waste with low salt content and a high carbon to nitrogen ratio can improve soil water intake, permeability, and structure.

Using Litter Nutrients Wisely

High nitrate levels in groundwater and high phosphorus levels in surface water may be an indication that too much litter or fertilizer is being applied on too little land. Yet the fact that poultry litter is high in nutrients is precisely its value. The nutrients in this resource make it an excellent soil conditioner and fertilizer. Growers can maximize the benefits of having this resource and help protect their local water resources from high nutrient levels by planning and operating an effective nutrient management system.

Application practices will vary with the area's cropping practices, topography, and other environmental and economic conditions. Waste and soil testing are the simplest and most important aspects of nutrient management. They help farmers monitor the nutrient supply to guarantee that it is adequately controlled to produce the best crop yields and maintain water quality. When properly recycled, nutrients are not wastes but opportunities to improve the overall farming operation.

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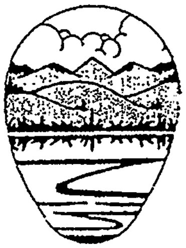

Putting Nutrient Management to Work

Land application, especially field spreading, is in most cases the best use of poultry wastes. It recovers nutrients that would otherwise be lost, improves yield, and reduces the possibility of releasing this material to water and the environment.

Where land is available, manure applications can be substituted for commercial fertilizers, reducing the farmers' costs and helping them comply with environmental laws. At the same time, land applications tend to use the largest amount of waste closest to the point of production.

To ensure that nutrients in waste are not overapplied to the land, the waste must be analyzed for the amount and type of nutrients it contains and the timing of applications must be adjusted to ensure that growing plants can use the nutrients. To accomplish this outcome, the litter should be uniformly applied at the recommended rate. The management practice that offers this assurance is nutrient management planning.

Nutrient management planning as a preliminary to land application has become a standard practice for recovering and using the nutrients in solid and liquid animal waste. It is, like composting, a centuries-old practice, which modern technology has substantially improved. The improvement — in a word — the ability to plan exactly how much manure should be applied — was highly recommended in the early 1990s. In 1995, the poultry industry in the Commonwealth of Virginia announced the decision of its four major integrators to require all new producers to have nutrient management plans. Nutrient planning has since become a requirement in many states.

What Is a Nutrient Management Plan?

Nutrient management planning matches the nutrient needs of the plants and soil with the nutrient contents in the manure to achieve a proper nutrient balance. An effective nutrient management plan consists of the following core components:

- farm and field maps,
- realistic yield expectations for the crops to be grown,
- a summary of the nutrient resources available (the results of soil tests and nutrient analyses of manure, sludge, or compost),
- an evaluation of field limitations based on environmental hazards or concerns (e.g., sinkholes, land near surface water, highly erodible soils, steep slopes),
- application plans based on the limiting nutrient,
- plans that include proper timing and application methods (avoid application to frozen soil and during periods of leaching or runoff), and
- calibration of nutrient application equipment.

Experience will continue to refine this practice. For example, nutrient management is very often based on nitrogen as the limiting nutrient. Nitrogen is a challenging nutrient to manage; it is highly mobile, easily dissolving in runoff and leaching through soil. Phosphorus, on the other hand, is less mobile so it is less likely to move off-site. Buffer zones and filter strips are also planted at the edge of fields and around water